

OBSERVATIONS ON BREEDING BEHAVIOR OF
PACHYDIPLAX LONGIPENNIS
(ODONATA:LIBELLULIDAE)*

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INTRODUCTION

Pachydiplax longipennis Burmeister is a medium sized dragonfly found throughout the United States. Clifford Johnson (1962) has described the general pattern of breeding behavior of this species in North Carolina, Virginia and Texas. In this paper I report my observations of three populations of this species in Massachusetts. While territorial and mating behavior is similar to that described by Johnson, I am able to extend his findings in some areas. In addition, I describe the coloration of this species in ultraviolet light and speculate as to the behavioral significance of the high reflectancy of areas of blue pruinescence.

METHODS

Observations were made at three ponds near Boston, Massachusetts, during the period June-August, 1974. *Pachydiplax longipennis* was relatively abundant at each pond. Observations were made throughout the daily activity period and under a variety of weather conditions.

Initial observations were made at Pickman Pond at the Concord Field Station of Harvard University in Bedford from June 13-July 18. This is a shallow man-made pond of about 1.5 hectares. The banks are thickly vegetated with bushes and sedges; the surrounding vegetation has been mapped by Maguire *et al.* (1973). Water depth within 2 m of the shore was typically 20-50 cm. Fallen branches and emergent vegetation, such as water lilies, lined the periphery. In early July, studies were conducted at a second shallow, artificial pond in Lexington (Five Fields: ca. 0.5 hectares), where the lack of dense fringing vegetation facilitated detailed observations. The pond was bordered on two sides by grassy banks and overhung by trees (mostly *Acer rubrum*). Emergent vegetation included

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arrow head (*Sagittaria latifolia*). Observations were made daily until August 8, by which time the water had dropped to such a level that few emergent perches suitable for *Pachydiplax longipennis* remained. On August 12, observations were commenced at a third shallow, artificial pond off Shade Street in Lexington. This 1.2 hectare pond was completely surrounded by trees (*Acer rubrum* and *Alnus* sp.) and emergent sticks and logs suitable for perches were plentiful.

At the Five Fields pond, attempts were made to study behavior by marking males. These attempts were largely unsuccessful due primarily to failure to relocate marked individuals. Thereafter, identifications of individuals were made by recording natural variations.

Some preliminary studies were made of the ultraviolet reflectant properties of the blue-grey abdominal pruinescence. With the collaboration of Robert E. Silberglied (Department of Biology, Harvard University) ultraviolet patterns were examined, using a 35mm single-lens-reflex camera with Zeiss F.4, 60mm Ultraviolet Objektiv lens, Zeiss UV 366 filter (=Wratten 18A), Bowens Texturelight electronic flash, Kodak Tri-X Pan film, and Acufine developer.

Although most of my observations confirm those of Johnson (1962), I found that there was a difference in male perching behavior. These and some additional observations are reported below.

MALE-MALE INTERACTIONS

From the time of their arrival (approx. 10 a.m.) until their departure (approx. 4 p.m.), the males observed defended a defined territory as described by Johnson (1962). The "threat display" (Johnson, 1962) was also frequently seen. Following this display, I observed that the two males engage in further agonistic behavior. One male pursues the other in a horizontal direction with abdomen raised while the leading insect flies with abdomen lowered (Fig. 1a). The two may repeat this behavior several times, exchanging positions and/or reversing direction after flying a distance of 1-2 meters. (They may alternatively resume the "threat display." Occasionally this may involve only one male if the other has returned to a perch.) After a variable duration (usually less than a minute) this pursuit behavior is discontinued and the males may begin a third behavior, as Johnson (1962) noted. Then, as I observed, the male who does succeed in getting the lower position, flies upwards, forcing the other up with him as much as 15 meters into the air at an angle of 50-80

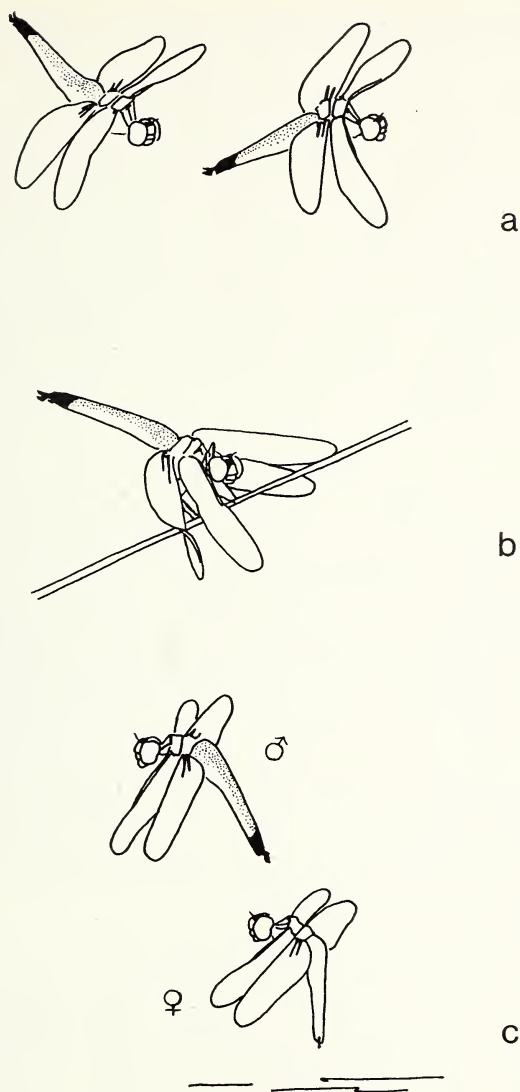


Figure 1. *Pachydiplax longipennis*: a, male-male chasing behavior; b, male perching position; c, male-female precopulatory position.

degrees. Immediately, one male returns directly to defend the territory while the defeated male returns many seconds later to rest or does not return to the area at all. Unfortunately, the flight speed was so great, and the distance so far, that I was unable to determine which male claimed the territory, or whether either regularly did, but I would hypothesize that the lower and therefore faster male usually dominates. As Johnson (1962) stated, this is the final step in establishing territorial dominance between two males. At any time one male may abandon this territorial dispute and retreat out of the area leaving it for the remaining male. In further agreement with Johnson (1962), I observed that the original owner often retains the territory. Such disputes generally last from 5 to 50 seconds and terminate with territorial possession and perch display by the dominant male.

PERCHING POSITION

The perching position of *Pachydiplax longipennis* is probably determined by several factors including wind, sun intensity, air temperature, the kind of perch, and the behavior of other dragonflies. Under typical summer daytime conditions when the wind speed is low, a male in an open situation exposed to full sunlight, usually aligns his body along the length of the perch. He raises his abdomen only a few degrees and brings his wings forward (Fig. 1b). Every 10 to 60 seconds he leaves his perch to patrol but returns directly if undisturbed by intruders. Very rarely did any male raise his abdomen to the extent illustrated by Johnson (1962: Fig. 2). On windier days, males keep their wings fully outstretched and at right angles to the prevailing wind. Only on hot calm days, when the air temperature rose above 30°C, did perching males raise their abdomens higher.

My observations, coupled with Johnson's (1962), suggest that male perching behavior is influenced by at least four factors including thermoregulation, aerodynamics, predator avoidance, and territorial display. It is interesting to note that whereas Johnson (1962) and Williamson (1900) reported that males generally perch with their abdomens directed upwards, this behavior was rarely seen in Massachusetts populations. Johnson and Williamson's observations were made on sunny days, at stations where daytime temperatures are typically 2-4°C higher than those prevailing in Massachusetts. This suggests that this behavior may be temperature dependent. As male-male territorial interactions were otherwise fully developed in the Massachusetts populations, I suspect that the abdomen orienting

behavior may be primarily thermoregulatory in function rather than purely for territorial display as concluded by Johnson (1962).

MATING AND OVIPOSITION

Pachydiplax females were infrequently seen at the three ponds. During July and August only 25 matings were closely observed. Females appeared between 1300 and 1500 hours (E.S.T.) on warm sunny days and courtship commenced immediately. A territorial male, upon seeing a female within his territory, would fly directly to a position above her. Hovering a few centimeters above her he would raise his abdomen in a manner similar to that seen in the threat display. (But in a position that makes it difficult for the female to see this display.) He then flaps his wings rapidly in an unusually wide arc. A receptive female will permit the male to align his body directly above hers. The male then descends and the female rises up slightly while lowering her abdomen and presenting her head (Fig 1c). In rapid sequence he clasps her with his abdominal appendages and they go into copula. Copulation occurs in flight and is brief, lasting 10-40 seconds. Its duration appears to depend, in part, on the number of previous inseminations received by the female, but only by collecting data could this speculation be verified. The pair then separate and the male returns directly to his display perch. On three occasions the male was seen to transfer sperm to his genitalia during this short postmating flight. Typically, the female also rests for 5-10 seconds on a nearby perch before searching for oviposition sites.

Oviposition was observed as illustrated by Needham and Westfall (1955). I found that the male defended the female from interference by other males only as long as she remained within his territory. The flight of these defending males was more directed and intense than that seen in male-male interactions. Nonetheless, in a few cases, when many males were present and/or when the female strayed out of her mate's territory, his fervent defense was inadequate and oviposition prevented. A behavior, marked in *Libellula incesta* Hagen but less common in *P. longipennis*, occurred when unmated males attempted to grasp the female while her head was exposed during oviposition. The female was usually knocked, tumbling, into the water. *L. incesta* females, being stronger fliers, would attempt to evade such attacks; *P. longipennis* females usually retreated to the trees until male excitement diminished. In addition to interference from other males, frogs presented a major threat to females ovipositing near the edge of the ponds.

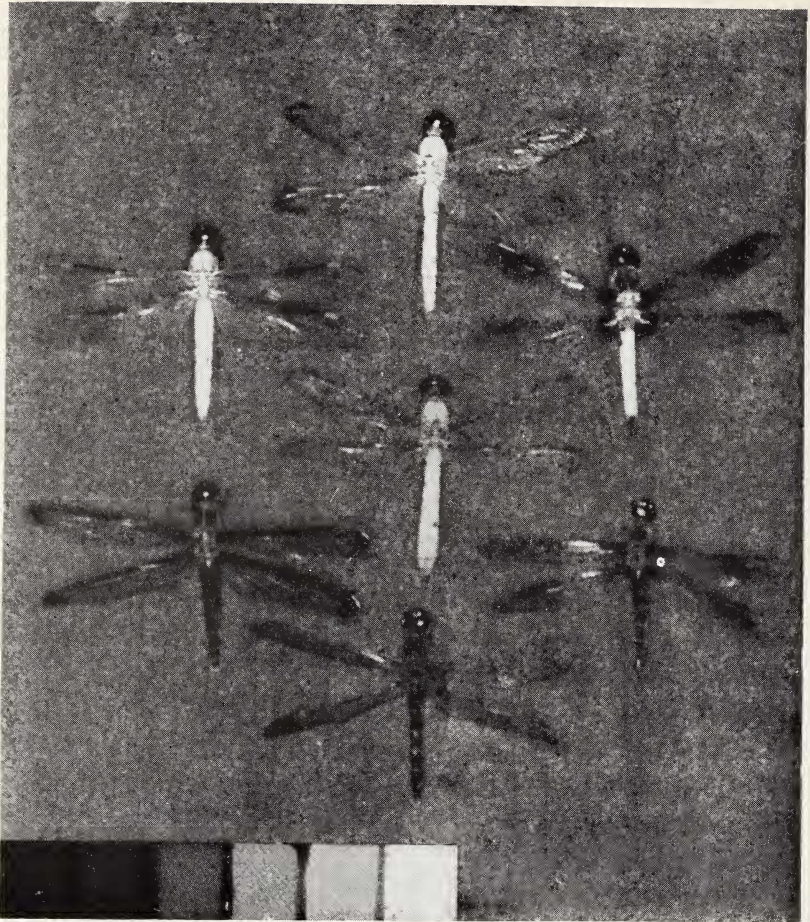


Figure 2. Three species of libellulids illuminated under 300-400 nm U.V. light. Percent reflection indicated in lower left corner: from left to right, 1%, 2.5%, 5.0%, 16.0%, > 25.0%.

INTERSPECIFIC BEHAVIOR

Pachydiplax longipennis males are unusually aggressive dragonflies when compared with other Libellulids. They react with particular ferocity to three larger sympatric species whose pruinosity color is similar to the grey-blue color of *Pachydiplax longipennis*. The first, *Libellula cyanae* Fabricius, most common at Pickman and the Five Fields ponds has a slightly darker pruinescence, covering the entire adult male body. *Libellula incesta*, common only at the Shade Street pond, has a much darker, almost black, pruinescence. The third, *Erythemis simplicicollis* Say, has the same color as *Pachydiplax longipennis*, covering a teneral green on the dorsal surface of the abdomen and synthorax. It occurred at all three of these ponds. *Libellula incesta* and *L. cyanae* sometimes occupy perches and enter the territory of *Pachydiplax longipennis*. *Erythemis simplicicollis* usually preferred to perch on an exposed log or rock, situations rarely used by *P. longipennis*. Despite its smaller size, *P. longipennis* would display and chase all three of these species that entered its territory.

Other dragonflies commonly present at these ponds included: *Plathemis lydia*, *Sympetrum rubicundulum*, *Leucorrhina intacta*, *Gomphus furcifer*, *Perithemis tenera*, *Libellula pulchella*, *L. luctosa* and *Ladonia julia*. *P. longipennis* males generally ignore them, presumably because of their different appearance.

COLORATION

Coloration patterns of recently dead males (killed by chilling) were compared in visible and ultraviolet light. It was found that the blue pruinose areas on the abdomen though dull under visible light have marked reflectivity in the ultraviolet. Highly reflective pruinescent areas were also found in males of *Libellula cyanae*, *L. incesta* and *Erythemis simplicicollis* (see Fig. 2), but were absent in females of these species.

Some odonates, including a libellulid, have been shown by physiological methods to be UV-sensitive (Goldsmith and Bernard, 1974: Table 5). Why is it that these, more stationary, libellulids have pruinescence in similar areas while in others it is a different color, located in different areas or absent all together? Species such as *Libellula pulchella* have only white pruinescent spots on their wings and are much more mobile than *P. longipennis*. In light of these preliminary findings, the possible role of ultraviolet patterns in odonate behavior deserves careful attention.

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